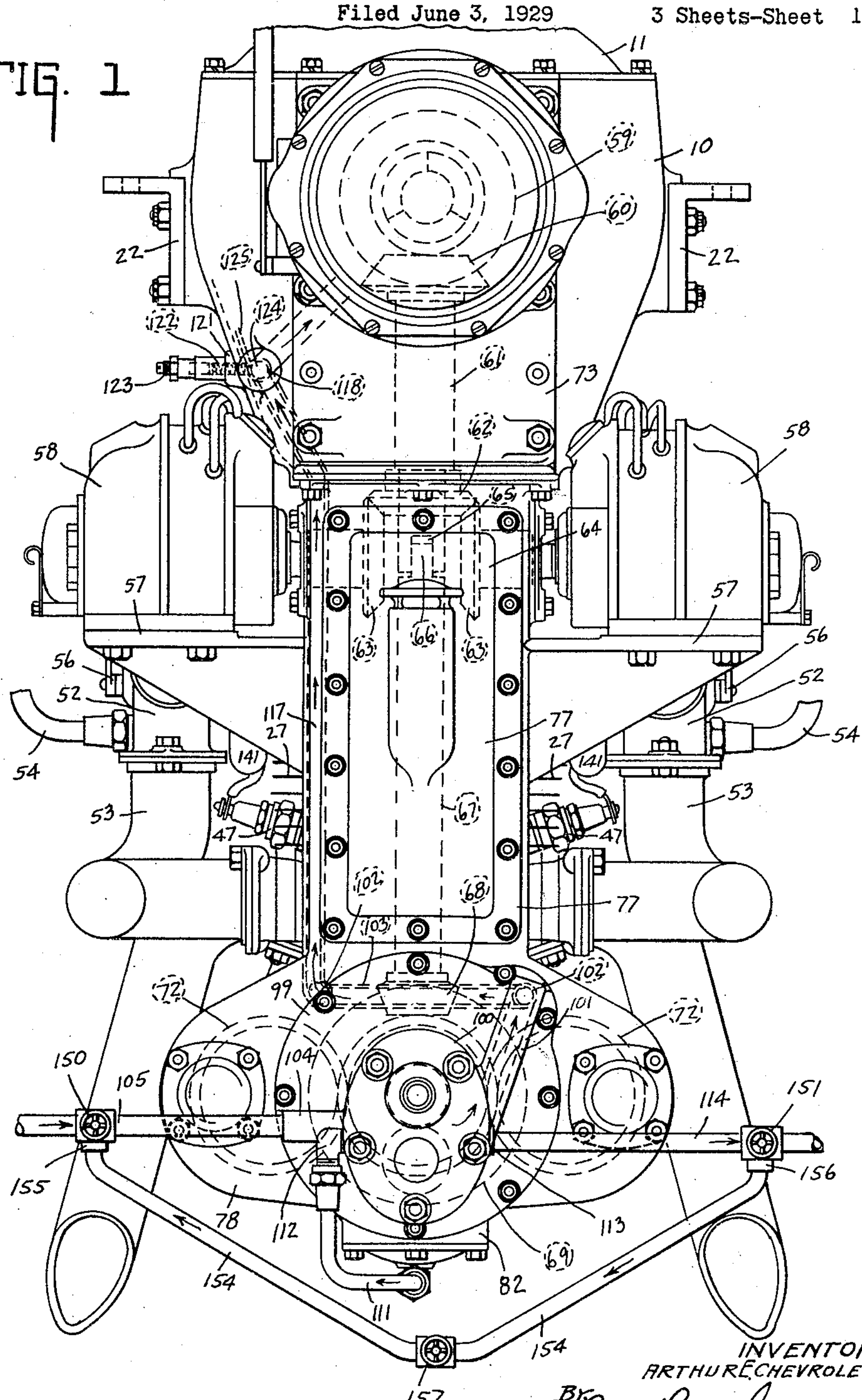
Oct. 18, 1932. A. E. CHEVROLET 1,883,558

AVIATION ENGINE

Filed June 3, 1929 3 Sheets-Sheet 1

FIG. 1



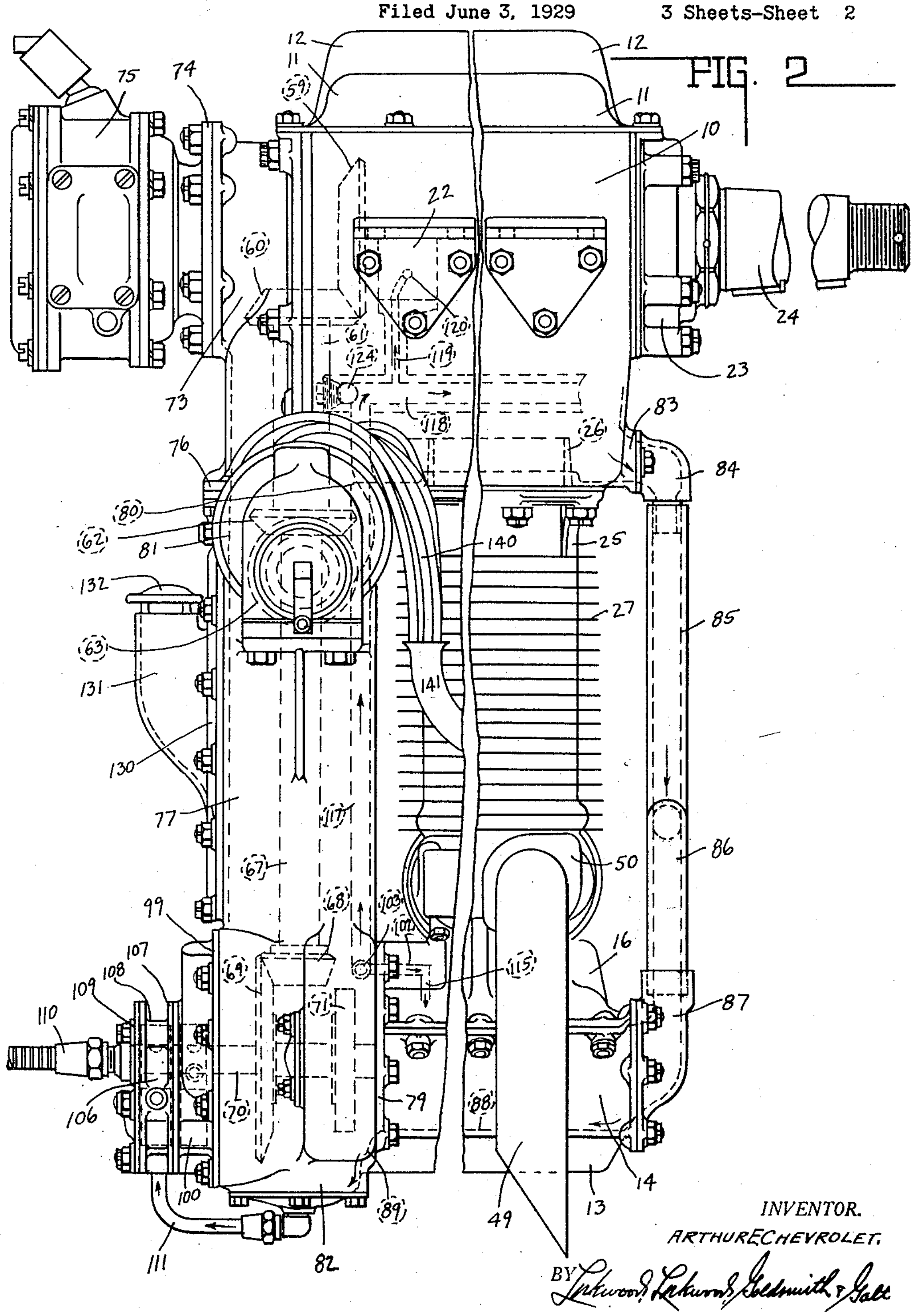
INVENTOR.
ARTHUR E. CHEVROLET.
BY Lockwood, Lockwood, Goldsmith & Galt.
ATTORNEYS.

Oct. 18, 1932. A. E. CHEVROLET 1,883,558

AVIATION ENGINE

Filed June 3, 1929 3 Sheets-Sheet 2

FIG. 2



INVENTOR.
ARTHUR E CHEVROLET.

BY Lockwood, Lockwood, Goldsmith & Galt

ATTORNEYS.

AVIATION ENGINE

Filed June 3, 1929 3 Sheets-Sheet 3

FIG. 3

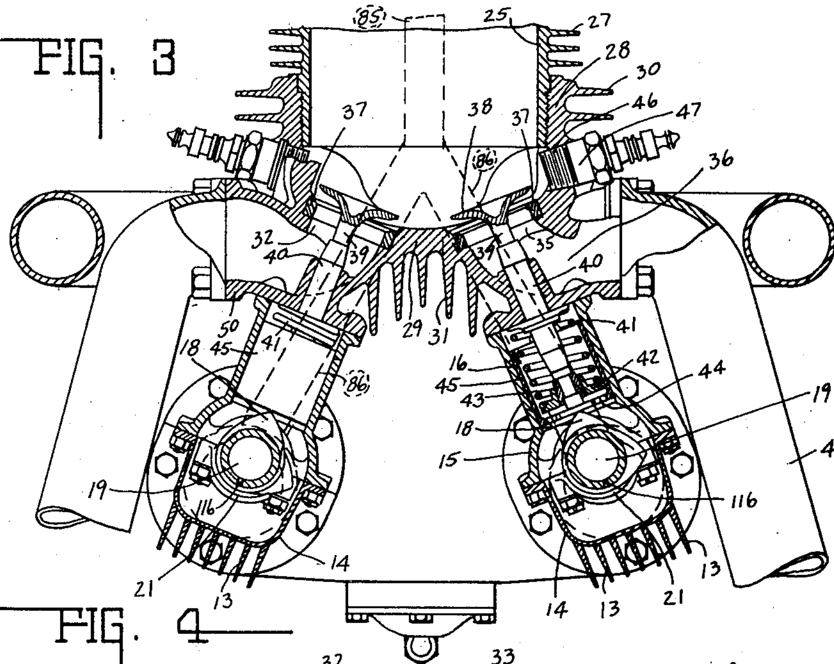


FIG. 4

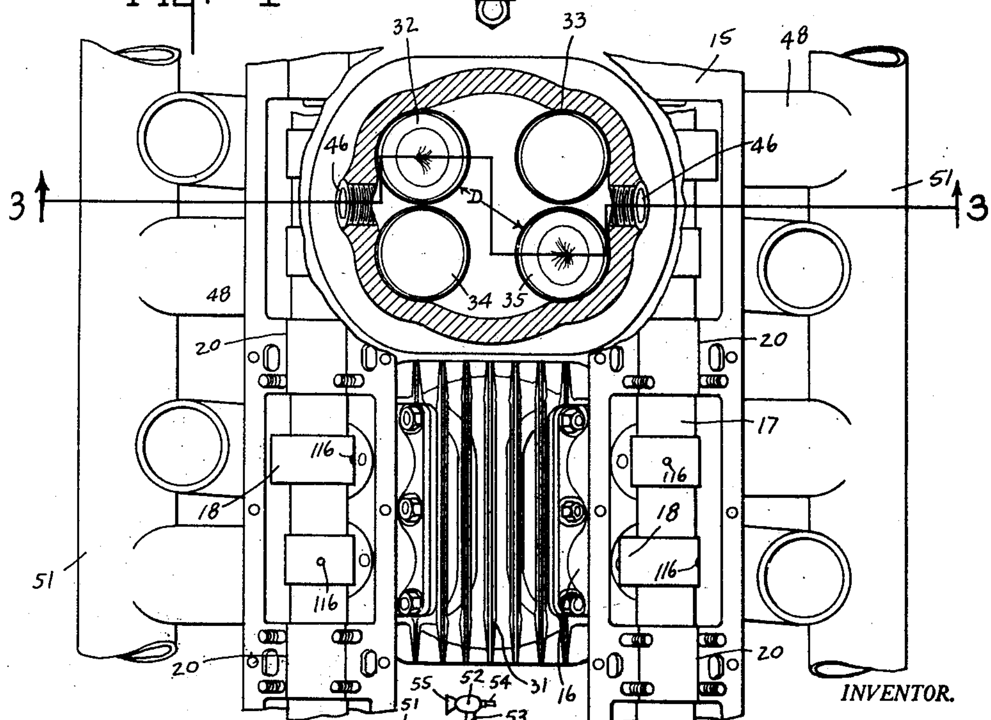
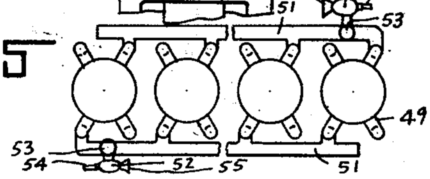


FIG. 5



INVENTOR.

ARTHUR E. CHEVROLET.

BY Lockwood, Lockwood, Goldsmith & Galt

ATTORNEYS.

Patented Oct. 18, 1932 1,883,558

UNITED STATES PATENT OFFICE

ARTHUR E. CHEVROLET, OF INDIANAPOLIS, INDIANA, ASSIGNOR TO CHEVOLAIR MOTORS, INCORPORATED, OF INDIANAPOLIS, INDIANA, A CORPORATION OF INDIANA

AVIATION ENGINE

Application filed June 3, 1929. Serial No. 367,966.

This invention relates to an in-line, multiple cylinder, air cooled, internal combustion engine suitable for aviation purposes.

The chief object of this invention is to provide an engine of the aforesaid character with but few parts and these of such a character that maximum safety is obtained, consistent with efficient engine operation and, in brief, the same may be defined as a uno-bi-lateral engine.

One of the features of the invention, in addition to the accomplishment of the foregoing object, consists in an improved lubrication arrangement whereby the lubricant has the dual function of lubrication and cooling, and the latter to a greater extent than heretofore employed.

Another feature of the invention consists in the arrangement of the several parts whereby greater air cooling is obtained than heretofore possible in the usual air cooled engine and the same is obtained through finning of the cam shaft housings, the crank case, as well as the finning of the cylinders and head. An additional cooling is obtained by the predetermined spaced relation of plural exhausts for each cylinder, whereby the heated gases are divided in their discharge from the cylinder and the amount of heat concentrated at any particular point of passage is thereby divided, and that portion included between the exhaust ports is of such an area that cooling thereof is readily obtained. The cooling action is further enhanced by the utilization of the incoming fuel to cool a common wall between the intake and exhaust, and at the same time, pre-heat the fuel supplied to the cylinder. Additional cooling is obtained by heat transmission to and diffusion from the cam shaft housings and exhaust pipes.

Another feature of the invention. in addition to the cooling action thus obtained, consists in the substantially uniform distribution of fuel to all of the cylinders irrespective of carburetion variation due to transverse or longitudinal tilting.

Miscellaneous features of the invention consist of the following:

The arrangement of the several parts such that the expansion in the cylinders and associated parts is compensated for or equalized so that distortion and strain is substantially eliminated;

Elimination of rocker arm mechanism through direct stem, tappet and valve connection;

Unitary drive for the ignition devices, cam shafts and pumps with ready accessibility to the same;

Parted cam shaft housing and crank case constructions permitting ready and rapid access to the crank shaft and cam shaft;

An improved valve, tappet and cam construction;

Other features of the invention will be pointed out more specifically hereinafter.

The full nature of the invention will be understood from the accompanying drawings and the following descriptions and claims:

In the drawings Fig. 1 is an end elevation of an air cooled in-line inverted multiple cylinder internal combustion engine suitable for aviation purposes and is of the end opposite the propeller, a portion of the crank case cover being omitted and the lubricating supply tank being likewise omitted, and additional parts not otherwise possible to show except by additional views being illustrated by dotted lines. Fig. 2 is a side elevation of the engine the intermediate portions between the ends being omitted and parts being shown dotted that are otherwise impossible to show except by additional views. Fig. 3 is an enlarged transverse sectional view of the engine taken on the broken line 3—3 of Fig. 4 and in the direction of the arrows. Fig. 4 is a bottom plan view of a pair of adjacent cylinders included in the engine with the cam shaft housing cover forming portion removed from each of the cam shaft housings and a portion of one cylinder being shown in horizontal section to show the valve seats therein. Fig. 5 is a diagrammatic plan view of a plurality of in-line cylinders showing the intake and exhaust arrangement for the same, the intake manifolds and the carburetors and their connections to the same.

In the drawings 10 indicates the crank case closed by a cover 11 having the longitudinally directed fins 12 thereon, said fins being in spaced relation substantially that as illustrated at 13, see Fig. 3, for the cam shaft housing forming cover 14, the housing being indicated by the numeral 15, and the valve guide extensions and cylinder head connections being indicated by the numeral 16. Herein there are a pair of cam shaft housing constructions and mounted in each is a cam shaft 17. The cam shaft 17 has formed on it several cams 18 and the cam shaft is hollow as at 19. The cam shaft is mounted in the cam shaft housing bearings 20 by suitable bearing caps 21, see Fig. 3.

The crank shaft is suitably mounted in the crank case, the latter having the external suspension brackets 22 extending laterally thereof, and said crank shaft although not shown in detail in the drawings is likewise hollow and is associated with the lubricating system as herein set forth. The crank shaft is extended beyond the crank case and is rotatably mounted by the end bearing cover 23, the shaft end being shown at 24 to receive the propeller.

Extending upwardly into the crank case is a steel cylinder 25, the projecting portion being indicated at 26 in Fig. 2, and said cylinder is suitably secured to the crank case and is suspended therefrom. The cylinder slidably supports a piston, and a connecting rod therein extends upwardly toward the crank shaft and is rotatably associated therewith. The cylinder 25 is peripherally finned as at 27 for air cooling. The cylinder 25 with the fins 27 at its lower end is receivable by the cylinder extensions 28 of the head 29. Cylinder extension 28 is peripherally finned as at 30 while the head construction 29 is otherwise finned as at 31, or for air cooling.

In each head there is provided four independent passages 32, 33, 34, and 35, and as shown in Fig. 4 passages 32 and 35, which may be the exhaust passages, are diametrically spaced relative to each other and are substantially valve diameter apart, the same being indicated by the dimension lines, and the letter D representing the dimension and the diameter of the valve. Thus the two exhause valves are positioned at the greatest distance apart and yet are in alignment with the remaining valves. As indicated in Fig. 3 at 31 this portion across the head is longitudinally finned. The same is also shown in Fig. 4.

The ports 33 and 34 are intakes and as shown in Fig. 4 the wall between the passage 32 and 34 is a common wall, and likewise the wall between the passage 33 and 35 is a common wall so that the incoming cool fuel mixture tends to cool this common wall so that relatively low engine temperature performance is obtained.

Each cylinder, therefore, is equipped with four independent passages, each being indicated at 36 and in each is mounted a valve seat 37 to be engaged by a valve 38 carried by stem 39 slidably supported in the guide 40 carried by the head construction. The guide 40 extends through the head and into the valve guide housing extension 16. A coil spring 41 bears against the head and against a spring retainer 42 adjustably mounted as at 43 upon the valve stem. A substantially flat follower 44 having the skirt 45 is slidably and rotatably mounted in the extension 16. Each of the cams 18 as it engages the flat face of the slidable and rotatable follower in its rotary movement imparts a slight rotary movement to the follower so that a new, or rather different surface is presented to the same cam upon each actuation until the follower has completed one cycle of rotation. In this way the wear upon the follower is reduced to a minimum and the same tappet clearance may be maintained for a greater length of time and possible sticking of the valve tappet will be greatly reduced.

Mounted in each of the openings 46 which are diametrically positioned with respect to each other in the cylinder, but which are inclined downwardly toward the valves are a pair of spark plugs 47. Oil which might pass the piston and normally would collect in the spark plugs if horizontally positioned or inclined towards the crank shaft, as has been the custom heretofore, in this form of the invention does not collect in the spark plug for carbonization or shorting the same, and, therefore, the spark plugs, by reason of this positioning are self-draining, not only for lubricating oil but also for liquid fuel that has not vaporized and burned.

Suitably secured to each flange 50 defining the end of the passage 36 and for each exhaust passage is an exhaust pipe 49 which extends outwardly and downwardly in diverging relation. Similarly secured to each flange of the intake passages 36 is a passage 48 of the intake manifold 51.

As shown clearly in Fig. 5 the preferred connections are as follows:—A pair of carburetors conventionally, illustrated in Fig. 1, and indicated by the numerals 52 are connected to the intake manifolds by the extension 53. The fuel line is indicated by the numeral 54. The air intakes of the carburetor are indicated by the numerals 55.

As shown in Fig. 5 the carburetors are oppositely directed so that tilting of the engine will in the usual float type carburetor flood one carburetor and starve the other so that the fuel mixture discharged into one intake will be relatively rich and that discharged into the other intake will be relatively lean. Since each manifold 51 connects to each cylinder the total amount of fuel supplied to each cylinder is substantially the same.

To insure uniform fuel distribution to the several cylinders when the plane is tilted longitudinally, and also to secure uniform fuel distribution when the plane is not tilted, one of the carburetors is connected to one of the manifolds near the front end of the engine and the other carburetor is connected to the other manifold near the rear end of the engine. Thus if there should be any variation by reason of longitudinal tilting of the engine, the same is automatically compensated for in each cylinder by the aforesaid arrangement. Furthermore the suction of the cylinders will supply a relatively larger charge to the second and adjacent end cylinders immediately connected to the carburetor connection to the manifold, while the more remote manifold connected cylinders will receive a relatively smaller mixture. However, with the fuel supply arranged as illustrated, each cylinder will receive approximately the same amount of fuel for any given throttle position.

The throttles indicated by the numerals 56 may be connected together or may be connected for independent operation as desired. In actual practice both throttles will probably be connected together for simultaneous dual control.

Should any carburetor fail, or should the fuel supply line thereto become clogged, the other carburetor will continue to supply fuel to its manifold and thus to all the cylinders.

Should any cam shaft fail, the other cam shaft will continue to operate and thus sufficient valve actuation will be obtained which is necessary to operate the engine.

Mounted upon the brackets 57 are the ignition devices 58 which may be standard devices actuated as hereinafter set forth, and each ignition device 58 is connected to one set of plugs 47 so that in the event of failure of any ignition device the other ignition device will supply ignition for the engine. Preferably the ignition control is of multiple type so that for test purposes each set of plugs may remain deenergized so that any fouled or shorted plug or plugs in either set can be determined, and a common control for the ignition may be provided in addition to the dual control so that the ignition for both may be simultaneously supplied to all or removed from the plugs in the starting and the stopping of the engine respectively.

The invention, therefore, is uno-bi-lateral in that the main body of the invention is a unitary engine including a single crank shaft, a single piston for each cylinder, a single connecting rod between each piston and the crank shaft, while the remainder of the engine is dual. In this respect the engine is similar to man, in that the engine may have a failure in a valve, a cam shaft, a spark plug, an ignition device, an intake manifold or a carburetor and still function satisfactorily for safety purposes just as a man who might lose the sight of one eye, hearing in one ear, one arm, or a leg might yet be perfectly competent to earn a living and maintain a useful life.

It has been the experience in aviation and automotive practice that it is some single mechanical failure of one of these aforesaid duplicated parts that has caused all the engine failures and most of the wrecks. It is relatively improbable that both carburetors, both cam shafts, or both ignition devices will fail at the same time. A plug of one set may fail to fire in one cylinder and a plug in the other set may fail to fire in a different cylinder and still the engine would operate satisfactorily, in fact in this type of failure but little loss of efficiency would result. If both plugs in the same cylinder were to fail through carbonization, or oil pumping in that particular cylinder, then the other three or more cylinders would function, and there would still remain sufficient power in the plane equipped with this engine to carry on and make a safe landing.

The reference made to three or more cylinders is intentionally made as such because the engine as illustrated in Fig. 2 may represent the two end cylinders of a 2, 3, 4, 5, 6, 8, 10 or 12 cylinder engine, the cylinders of which are arranged in line. The preferred number of cylinders, however, is 4, 6, and 8 and if 8, 12 or 16 cylinders are desired and the overall length of the engine is objectionable, the cylinders may be arranged in two banks in V-arrangement at the proper angle and have 4, 6 or 8 in bank. Each throw of the common crank shaft then will be connected to two connecting rods connected to a piston in each of the banks and mounted in one of the cylinders in that bank. This change from a single bank to a V-type engine is quite conventional in automotive practice and is well understood in internal combustion engine practice. The features of the invention herein illustrated as applied to an in-line single bank construction, therefore, when thus modified as hereinbefore suggested, may be practically embodied in the multiple bank type engine without any material modification.

The crank shaft supports a main driving bevel gear 59 which meshes with a bevel gear 60 carried by the end of the vertical shaft 61. The vertical shaft 61 at its lower end supports a bevel gear 62 that meshes with a pair of bevel gears 63 each of which is mounted upon a lateral shaft 64 which is the ignition device or magneto drive shaft. The shaft 61 includes an elongated slot 65 in its lower end which receives an elongated tongue 66 of the shaft 67 that mounts in its lower end bevel pinion 68 that meshes with the bevel gear 69 . Bevel gear 69 is carried by a short shaft 70 positioned in the same vertical plane as the crank shaft, see Fig. 1, and it extends outwardly from the engine as a fuel pump drive. The short shaft 70 is extended toward the cylinders and mounts the spur gear 71 that meshes with gears 72 rigid with the cam shafts 17 and thus the cam shafts are rotated through a splined connection or longitudinally extensible driving connection from the crank shaft.

A vertical housing member 73 is secured to the end of the crank case and mounts a cover 74 that supports starter 75 when the same is desired. The housing 73 terminates at 76 and another housing 77 communicates therewith and with the crank case. The housing 77 is flared outwardly as at 78 and forms a gear chamber for the cam shaft gear and the cam shaft housings are secured thereto as at 79, see Fig. 2.

As shown clearly in Fig. 2 the cylinders 25 project upwardly into the crank case as at 26 and the dotted lines 80 and 81 in Fig. 2 in the housing 73 and 77 illustrate the oil return from the crank case to the sump 82 at the bottom of the cam shaft housing and the crank case connection 77.

If the plane were always on a level keel the crank case bottom could be flared or inclined so that it would normally drain through the housing before-mentioned, but in descending, the plane will tilt downwardly in a forward direction, and in that event the oil in the crank case would collect therein at the forward end and overflow into the cylinders with possible disaster. Therefore, the forward end of the crank case at 83 is provided with an outlet 84 with which is telescopically associated a return pipe or conduit 85 having two branches 86, see Figs. 2 and 3, each end of which may be telescopically associated with the fixture or intake 87 secured to the forward end of the cam shaft housing 14. Thus the cam shaft housing 14 receives the oil discharged through the forward end return connection, and the same passes along the bottom 88 of the covers and discharges as at 89 to the sump 82.

The crank case, cam shaft housings, and cylinder heads 29, are of an aluminum alloy having sufficient strength and the desired lightness in weight. The housing 73 and housing 77 are of similar material. The cylinder 25, however, is of steel and the alloy has approximately three times the co-efficient expansion as the steel. However, the steel is about three times as hot so that the actual elongation between the cam shaft housings and the crank case is substantially equal at each cylinder, and in the lubricant return including the crank shaft drive inclosing housing. Therefore the longitudinally extensible tongue and groove drive 65—66 is elongated with the expansion or elongation due to heat and forward oil return will also elongate through the telescopic connection or mounting of the pipe 85 and its branches 86.

Lubrication system

In addition to the portions of the lubrication system previously described it is to be noted that the cam shaft housings 14 provide two elongated sumps each of which receives a portion of the lubricant and, therefore, the cooling of the oil is very effective when it will be remembered that each sump is provided with the elongated vanes or heat rediating fins 13.

The front end of the common connection between the cam shaft housing indicated by the numerals 78 and 82 formed upon the lower portion of the member 77 is closed by a cover 99 which has formed thereon the body portion 100 having the discharge channel 101 that communicates with an elongated passage 102 that extends the full length of the cam shaft housing. A cross channel 103 is similarly connected to another channel 102 in the other housing. The intake to the pump is indicated at 104 and is supplied by a line 105 from an oil storage tank not shown. The gear pump mounted within the housing portion 100 consists of the usual two meshing gears, not shown, and one of the same is carried by the outwardly extended end 106 of the shaft 70.

The pump body, therefore, is formed as a continuation of the cover 99. The cover for this pressure pump consists of the plate 107 which includes a body portion 108 that forms the body or housing of another pump closed by a cover 109, the shaft extension 106 extending through the same and terminating in a tachometer drive connection 110. A line 111 connects the bottom of sump 82 to the inlet 112 of the scavenging pump. This pump is likewise a meshing gear pump and the discharge 113 is connected by a line 114 to the tank from which lubricant is supplied to the pressure pump 105.

Each of the conduits 102 which are formed integral by casting pipe in the cam shaft housings, etc., discharge by lines 115 (see Fig. 2) to the cam shaft and cam shaft bearings. Each cam shaft includes discharge openings 116 that discharge lubricant to the intermittently rotated skirted tappets.

The transverse channel 103 communicates with the lower end of a conduit 117 and passes up through the housing 77 and the same discharges into a longitudinally directed conduit

118 in the crank case (see Figs. 1 and 2). The longitudinally directed conduit through the branches 119, supplies lubricant to each of the crank shaft bearings as at 120 and to the crank shaft since the same is hollow so that said crank shaft may, in turn, supply lubricant under pressure to the connecting rod bearings included therein.

Reference is had to Figure 1 wherein the supply line to the pressure pump includes a valve 150 and the discharge from the scavenging pump to the oil reservoir tank includes a valve 151. Normally these valves are always open when the engine is in operation. When not operating, valve 150 is closed to prevent flooding of the engine. Merely as a safety factor should leaks develop in the oil lines to and from the supply tank, a by-pass line 154 is connected through the fittings 155 and 156 to the pressure intake line and the scavenging pump discharge line, respectively. This by-pass line 154 includes a valve 157 which always remains closed except when leakage develops and then the scavenging pump is permitted to discharge direct to the pressure pump and, thus, conserve the oil initially trapped in the engine at the time of failure, permitting further engine operation sufficient for landing purposes. The by-pass and the connecting line 111 from the sump to the scavenging pump may be formed integral in the engine castings.

Mounted in the crank case is a relief valve construction including a housing member 121 which receives a spring 122, the tension of which is adjusted through the externally adjustable means 123, and the same bears on a ball 124 which controls the discharge line 125. When the pressure in the oiling system increases beyond that set by the member 123, the excess lubricant discharges through port or passage 125 into the crank case and housing connection 73—77 and flows back to the sump 82.

The front of the housing 77 is closed by a plate 130 which is provided with an upwardly extending possible filler conduit 131 closed by a cap 132 whereby the single filler device discharges to the tubular connection or housing 77 and the lubricant may be supplied through the opening partially closed by the cap 132 and collects in the sump 82 and from thence is fed to the several parts of the system. The portion 131 covered by the cap 132 also constitutes a breather construction for the engine.

As is common in all engines the ignition wires 140 are preferably inclosed in a protective cable or conduit construction 141 and each wire 140 passes out through a lateral opening therein to the respective spark plugs 47.

While the preferred form of carburetor and manifold construction has been illustrated and described, it is to be understood that a single carburetor may be provided for each intake of each cylinder or for a plurality of intakes of a plurality of cylinders and preferably the intakes upon the same side of the engine.

The air stream for cooling is, of course, generated by the propeller and the same may be variously directed by suitable cowling or the like and the desired directional discharge or flow of air along, over and between the cylinders may be obtained as is well understood by those in the art through the application of the proper cowling including the desired and necessary baffles, vents and louvers.

As previously set forth the cylinders are of steel and each head is of aluminum alloy. Each cam shaft housing is of aluminum alloy, as well as each exhaust pipe. The cam shaft housings are directly connected to the head without the inter-positioning of any gasket or any other separating material, although there may be interposed, if desired, or when necessary, a metallic gasket such as copper or brass which, however, should have approximately the same co-efficient of heat conductivity. The purpose of this type of connection is to rapidly transmit the heat generated in the head away from the same and impart it to the cam shaft housings where the air passing over the cam shaft housings will rapidly cool the same, as well as the oil passing through said housing.

As illustrated in the drawings the two cam shaft housings are positioned in spaced relation with a central free channel therebetween and in this central free channel the central fins 31 on the head portion of each aluminum cylinder head extend so that air passing through this channel has direct contact without interference with the head supported fins for additionally cooling the cylinder head.

Similarly, the exhaust pipes are directly connected, although a metallic heat transmitting gasket might be interposed therebetween, to the heads and each exhaust passage is provided with an exhaust pipe of aluminum alloy or some other metal having a high coefficient of heat conductivity. The use of individual exhaust pipes is preferred to a combination manifold because of the greater periphery exposed to the air cooling stream by the use of individual pipes. The resultant construction, therefore, is one that rapidly transmits the excess heat from the head to other parts more remote therefrom for heat diffusion and which also permits of finning of the head at the hottest portions thereof so that the air for cooling the same may be very effective thereon.

While the invention has been described in considerable detail herein and parts have been semi-diagrammatically illustrated and several modifications have been specified, the same, as well as those which will readily suggest themselves to persons skilled in this art, all are considered to be within the broad purview of this invention, reference being had to the appended claims.

The invention claimed is:

1. In a multi-cylinder in-line air cooled valve-in-head internal combustion engine suitable for aviation purposes, the combination of a pair of exhaust valve seats for each cylinder, a pair of intake valve seats for each cylinder, an intake and exhaust valve being provided at each side of the cylinder and in line with others upon the same side of the engine, an independent passage associated with each seat, the exhaust and intake valves being diametrically arranged on opposite sides of the engine the passages upon the same side of the engine having a common intermediate wall and the exhaust valves on opposite sides of each cylinder having substantial valve spacing therebetween whereby cooling of the common wall by the incoming fuel and the spaced portion cools the exhaust passage portion thereof.

2. In a multi-cylinder in-line valve-in-head internal combustion engine suitable for aviation purposes, the combination of a plurality of air cooled cylinders, a pair of exhaust valve seats for each cylinder, a pair of intake valve seats for each cylinder, a valve for each seat, valves upon the same side of the engine being arranged in-line, the exhaust valves on opposite sides of each cylinder being arranged diametrically of each other with substantial valve spacing therebetween, and heat radiating fins arranged parallel to the in-line arrangement interposed between said exhaust valve seats for cooling the cylinder head between the valves.

3. In a multi-cylinder in-line valve-in-head internal combustion engine suitable for aviation purposes, the combination of a plurality of air cooled cylinders, a pair of exhaust valve seats for each cylinder, a pair of intake valve seats for each cylinder, a valve for each seat, valves upon the same side of the engine being arranged in line, the exhaust valves on opposite sides of each cylinder being arranged diametrically of each other with substantial valve spacing therebetween, an independent passage for each seat, the passages for each cylinder upon the same side of the engine having a common intermediate wall whereby incoming fuel cools the common wall and thereby cools the exhaust valve portion thereof, and heat radiating fins arranged parallel to the in-line arrangement carried by the cylinder between said exhaust valve seats for cooling the cylinder head included portion therebetween.

4. In an air cooled valve-in-head internal combustion engine adaptable for aviation purposes the combination of a plurality of cylinders arranged side by side and in line arrangement, each including a plurality of intake valve seats and each including a plurality of exhaust valve seats, a valve for each seat, the seats being arranged relative to each other so that there is an intake seat and an exhaust seat on each side of each cylinder relative to the longitudinal alignment thereof, the exhaust valve seats being arranged relative to each other so that a greater distance therebetween obtains than betwen the intake and adjacent exhaust valve, and heat radiating fins positioned between the in-line valve arrangements and parallel to the in-line arrangement.

5. An air-cooled internal combustion, multiple cylinder, in-line valve-in-head engine including intake and exhaust valves for each side of each cylinder, two intake manifolds one at each side of the engine and each connected to all the cylinders, a carbureting device for each manifold, a single crank shaft above the cylinders, a pair of cam shafts one at each side of the central plane of the engine and positioned beneath the cylinders and for operating the valves at each side of each cylinder whereby dual semi-independent valve operation may be obtained, the cam shafts being spaced apart an appreciable distance with the in-line arranged valves within the inter space and in turn spaced apart for engine head and valve cooling.

6. In an air cooled engine the combination of a plurality of in-line steel cylinders, a crank case connected to each of the cylinders at one end, a cam shaft housing connected to each cylinder at the opposite end thereof, a crank shaft in the crank case, a cam shaft in the housing, longitudinally extensible means connecting the cam shaft and crank shaft, a second predetermined expansible housing at one end of the engine and connecting the same and inclosing the connecting drive, the cylinders and the connecting housings having different co-efficients of expansion and so arranged relatively to each other and the temperatures to which each is subjected that the actual expansion between the cam shaft housing and the crank case in each cylinder and in the connecting housing is substantially equal whereby straining or warping is substantially eliminated, each cylinder projecting an appreciable distance into the crank case, the crank case being positioned above the cam shaft housing, said second mentioned connecting means consisting of an oil return from the crank case to the cam shaft housing, the latter serving as a sump, and another and longitudinally extensible oil return connecting the crank case to said cam shaft housing, whereby tilting of the crank case will not prevent drainage of the oil therein to the cam shaft housing.

7. In a multiple cylinder, in-line, internal combustion engine the combination of a crank case, a plurality of cylinders connecetd at one end to said case, an intake valve and an exhaust valve for each cylinder and upon

each side thereof, said valves being arranged in two parallel lines, a pair of cam shafts adjacent the opposite end of each cylinder, each cam shaft being arranged to operate a full set of valves in each cylinder, a crank shaft, a transverse shaft extending from the crank shaft toward the cam shafts, a pair of connections each connecting a cam shaft to the transverse shaft for cam shaft driving, another shaft positioned transversely of the transverse shaft and arranged to drive both cam shaft connections, and a pump operatively associated with said last mentioned transverse shaft.

8. In an inverted in-line-multiple cylinder, internal combustion engine, the combination of a crank case, a plurality of independent cylinders communicating therewith and each extending an appreciable distance into said crank case, a cam shaft housing therebeneath, independent means at each end of the engine separate and spaced from the cylinders and connecting the crank case to the housing for oil sump purposes, and heat radiating fins on said housing for oil cooling.

9. In an inverted in-line, multiple cylinder, internal combustion engine, the combination of a crank case, a plurality of independent cylinders communicating therewith and each extending an appreciable distance into said case, a pair of cam shaft housings for said cylinders, all of the cylinders being arranged in a single line, said housings being positioned beneath said crank case, and means connecting said crank case to the housings separate and spaced from the cylinders and for dual oil sump purposes, said housings being connected together for common drainage.

10. In an inverted in-line, multiple cylinder internal combustion engine, the combination of an overhead crank case, a plurality of independent cylinders communicating therewith and each extending upwardly into the case an appreciable distance, a crankshaft in the case and arranged for pressure lubrication, a plurality of cam shafts therebeneath and beneath the cylinders, a plurality of cam shaft housings for said cam shafts and constituting oil sumps for the engine, means connecting the housing sumps together for unitary operation, an oil pressure supply pump supplied from said pumps, tubular means other than the cylinders connecting the case and housings together at opposite ends and a scavenging pump connected to said housing connection for supplying said pressure pump.

11 In an inverted in-line multiple cylinder, internal combustion engine, the combination of an overhead crank case, a plurality of independent cylinders connected to said case and each projecting into the same an appreciable distance, a pair of cam shaft housings beneath the case and the cylinders and for each of the latter and connected to the same and constituting oil sumps for the engine, means connecting both ends of the crank case to both ends of the cam shaft housings including a common connection between said housings for unitary operation, and a pump connected to the connecting means for pressure lubrication of the engine.

In witness whereof, I have hereunto affixed my signature.

ARTHUR E. CHEVROLET.